

GSFC S-480-12

REV D: 04/85

GSFC SPECIFICATION

TIROS

SOLAR BACKSCATTER ULTRAVIOLET  
SPECTRAL RADIOMETER MOD 2

(SBUV/2)

JULY 1979

GODDARD SPACE FLIGHT CENTER  
GREENBELT, MARYLAND

PAGE EFFECTIVITY: APRIL 1985

ISSUE: All pages not listed below.

|       |        |   |
|-------|--------|---|
| 10/80 | REV A: | Sect. 4; pps. 3, 12, 17, 18, 22, 25, 26, and 43<br>Sect. 6; pps. 2 and 14<br>Sect. 7; pps. 1, 2, 3, 6, 8, 10, 11, 12, and 14<br>Sect. 8; pps. 1, 2, 8, 10, and 14<br>Sect. 10; pps. 3 and 4                                     |
| 01/81 | REV B: | Sect. 1; pp. 1<br>Sect. 4; pps. 1, 6, 8, and 16   |
| 12/82 | REV C: | pp. v<br>Sect. 2; pp. 1<br>Sect. 4; pps. 7, 13, 14, 15, 21, 23, 24, 27, 28, 29, 30,<br>31, 32, 35, 37, 41, and 46<br>Sect. 5; pps. 2, and 3<br>Sect. 6; pps. 15, and 17<br>Sect. 7; pp. 15<br>Sect. 9; pp. 1<br>Sect. 10; pp. 5 |
| 04/85 | REV D: | pps. iii, iv, and vi<br>Sect. 4; pps. 3, 38, 39, 45 and 46<br>Sect. 5; pps. 4, 5, and 6<br>Sect. 6; pps. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 18<br>Sect. 10; pps. 1, and 5<br>Sect. 11; pps. 1 and 2                      |

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## 4.2 OPERATIONAL REQUIREMENTS

### 4.2.1 Nominal Orbital Parameters

Orbit Altitude -  $834\text{km} \pm 18.5\text{km}$  or  $871\text{km} \pm 18.5\text{km}$

Orbital Period - 102 minutes

Longitude Shift - 25.25 degrees/orbit

Orbit Inclination - 99 degrees

Longitude of Orbit Nodes - 0600 to 1000 descending and 1400 to 1800 ascending, local mean time.

Gamma Angle (angle between the orbit normal and the solar vector) - 0 to 68 degrees for NOAA-F and -G; 0 to 80 degrees for NOAA-H and up.

### 4.2.2 Operational Modes

The following operational modes are defined for the SBUV/2:

- \* Launch Phase and Orbital Acquisition Mode: Instrument status will be defined for this flight phase.
- \* Mission Mode: Normal operating mode of the instrument.
- \* Activation Mode: Initial turn on and warm up of the instrument.
- \* Standby Mode: Minimum power mode for survival; this is a planned shutdown.
- \* Safe State Mode: Emergency off mode; this is a spacecraft emergency and the intent is that all instruments will be reactivated upon spacecraft recovery.

### 4.2.3 Life Requirements

The SBUV/2 shall be designed to operate continuously within specification for two years in orbit and three months of operating time at the spacecraft contractor's facility following a maximum period of five years in storage. All age sensitive parts, materials, and components relative to the 5 year storage period, shall be identified in writing and the information submitted to the Technical Officer by the Critical Design Review. During the storage period the instrument will be turned on and operated in all of its modes (aliveness test).



#### 4.6.1.11 Finish

The external finishes applied to the Sensor Module shall satisfy the optical, thermal, and mechanical requirements of the spacecraft and the SBUV/2.

#### 4.6.2 Spacecraft Interface Requirements

##### 4.6.2.1 Mounting

The mounting face of the Sensor Module housing shall be considered part of the baseplate and as such shall include the mounting feet, thermal insulation if required, and any other interface connected subassemblies.

##### 4.6.2.2 Interface Alignment

A method shall be provided for measurement of the alignment of the SBUV/2 optical axis with respect to three external reference surfaces on the instrument base. Provision shall be made to precisely attach alignment mirrors to these surfaces. These mirrors in turn may be used to boresight the SBUV/2 to the spacecraft and must be located to be seen from the nadir view, along the thrust axis and along the velocity vector. The measurement of the optical axis alignment with the mirrors shall have an accuracy of 0.1 degrees or better, and the measurement precision shall be 0.01 degrees. The mirrors can be permanently attached, but if they are removable, measurement repeatability must be 0.005 degrees or better after mirror removal and replacement. The reference axes shall correspond to the spacecraft X, Y and Z axes. Therefore, the instrument mounting plane is the Y-Z plane and the +X axis is nadir. The instrument mounting feet shall have a coplanarity of 0.005 inch and the mounting hole pattern shall be aligned within 0.1 degrees of the instrument Y and Z axes.

##### 4.6.3 Encoder

The monochromator drive position shall be read out with an optical encoder having a minimum angular resolution corresponding to a nominal wavelength shift no greater than 0.1nm. The alignment of the encoder reference pulse to the encoder fine tracks shall be no greater than 2 arcseconds.

##### 4.6.4 Monochromator Drive Assembly

The monochromator drive shall be designed to spectrally scan from 160nm to 400nm in a series of nominally equal steps, each step corresponding to a spectral shift no greater than 0.1nm. Each individual step shall be within + 25 percent of the average step size, with a repeatability of + 1.5 arcseconds. In addition, the monochromator drive assembly shall have the in-orbit capability of changing each Discrete Mode central wavelength to within + one-half resolution element of any selected wavelength in the 160nm to 400nm spectral range of the instrument.

#### 4.6.5 Phase Reference Pickup (PRP)

The PRP, if used, shall be designed to permit sufficient mechanical adjustment of the PRP signal phase relative to the scene signal and all components of the PRP subassembly shall be redundant.

#### 4.6.6 Protective Covers

##### 4.6.6.1 Contamination Covers

The instrument contractor shall provide removable protective cover(s) and/or other contamination protection capable of protecting the Sensor Module from organic molecular and particulate contamination during all phases of spacecraft integration and testing through final closure of the shroud. In the event that certain mounting hardware, or other portions of the contamination protection system, cannot be removed from the instrument without first removing the instrument from the spacecraft this hardware can remain on the instrument for flight, providing it is flight worthy and is included in the instrument's overall allowable weight budget.

a. Spacecraft Mounting—The cover(s) and/or other contamination protection shall protect the Sensor Module, with Lifting Fixture attached, until it is mounted on the spacecraft.

b. Primary I&T Operations—The cover(s) and/or other contamination protection system shall protect the Sensor Module from contamination while it is on the spacecraft or in the spacecraft integration and test area but unmounted. This system shall be purgable with clean, dry GN<sub>2</sub> capable of maintaining a class 100 environment within the instrument's optical cavity (the cavity will be as clean as the gas used to purge it), and any portion of it that will not fly shall be visible and RF transparent. This cover(s) and/or other contamination protection system shall be in place on the Sensor Module at all times after the instrument is mounted on the spacecraft except for those test situations requiring use of another specialized cover(s), including optical alignment, and shall not inhibit operation of the instrument. Two sets of removable items suitable for use in this environment are required for each instrument.

c. Vibration, EMI, and Acoustic Testing—The cover(s) and/or other contamination protection system (except for flyable items) shall be visible and RF transparent when used with the Sensor Module during spacecraft vibration, EMI, and acoustic testing. It shall be purgable but the purge must be safely removable during actual test periods. The cover(s) and/or other contamination protection system must allow unhindered depolyment of the diffuser and cal lamp housing, but must not invalidate or inhibit the environmental testing for which its use is required. Should any removable items provided for use in other environments not be usable in this context, one set of unique section (c) removable items is required.

d. Thermal Vacuum-Testing—The cover(s) and/or other contamination protection system shall be used to protect the Sensor Module during spacecraft thermal vacuum testing. It must allow venting of the instrument during chamber pump-down while at the same time it must protect the inside of the Sensor Module from contamination by backstreaming pump oil. It must allow complete operation of the instrument in all its modes, including deployment of the diffuser and cal lamp housing, and must be IR transparent or designed as not to alter the instrument's thermal environment. Should any removable items provided for other uses not be usable or sufficient for use in this context, one set of unique section (d) removable items is required.

e. Launch Site Operations—The cover(s) and/or other contamination protection system shall be used to protect the Sensor Module during shipment to the launch site and during the period of spacecraft testing prior to mating with the AKM, at which time the visible and RF transparent covers will be replaced with a special antistatic and fire retardant cover(s) which will remain on the Sensor Module until final encapsulation of the spacecraft. This cover(s) will be the same size and shape as the cover(s) replaced and will be used at WTR only; two sets are required for each instrument.

#### 4.6.6.2 Flyable Covers

In orbit the diffusing mechanism shall be stowed behind a protective cover when not in use. A cover for the test connector(s) shall also be provided.

#### 4.6.7 Materials

Nonmagnetic materials shall be used whenever possible. The proposed use of any magnetic materials must be approved by the Technical Officer. Cadmium and Zinc shall not be used, and the use of Magnesium will be approved only if it can be clearly and unequivocally demonstrated to be cost effective. Sun shields, if used, shall contribute no more than a 2 db loss at radio frequencies in the range 136MHz to 1700MHz, and shall not be reflective within that range.

##### 4.6.7.1 Corrosion of Metal Parts

Metal parts shall be made from materials inherently corrosion resistant, or shall be processed to resist corrosion. Bare aluminum or bare magnesium shall not be used.

##### 4.6.7.2 Outgassing of Material

Materials shall not outgas, vaporize, or otherwise degenerate in a space environment in a manner and to a degree as to interfere with the operation of the instrument or any other spacecraft component. Each component shall be free from residual contaminants such as corrosion inhibiting oils, greases, dyes, shim stock, and similar debris.

#### 4.6.7.3 Materials Selection

Selection criteria for outgassing shall be a maximum mass loss of 1.0 percent or less and a maximum collected volatile condensable materials of 0.1 percent or less when tested according to ASTM E 595-77 (See Applicable Document 2.1(11)).

#### 4.6.7.4 Materials and Process Listing

The contractor shall prepare and furnish, prior to the Preliminary Design Review meeting, Materials, Lubrication, and Process Lists for those materials used in the SBUV/2. They will categorize all materials listed as metals, plastics, coatings, miscellaneous, etc., and adequately identify the items by government specification, process, cure cycle type, chemical composition and/or manufacturer. The Listing will also specify the application(s) of each material in the subsystem. The lists will be in the format of GSFC Form 18-59 A, B, C, and D and all information requested therein shall be provided. GSFC forms will be supplied upon contract award.

#### 4.6.8 Magnetic Fields

The SBUV/2 shall be designed to minimize the permanent, induced, and transient magnetic field effects. The magnetic field of the instrument shall not exceed 100 gamma at a distance of one meter from the instrument, when operating or not operating.

##### 4.6.8.1 Magnetic Susceptibility

The SBUV/2 shall be designed to minimize its susceptibility to magnetic fields. The instrument must operate within specification in the static and dynamic magnetic field environment of the spacecraft. The general magnetic field environment of the spacecraft is described in the GIIS, and the specific environment expected in the vicinity of the SBUV/2 is described in the UIIS.

#### 4.6.9 Decomposition Products

Design provisions shall be provided to avoid any adverse effects from orbit and adjust subsystems combustion products:  $H_2$ ,  $N_2$ ,  $NH_3$ ,  $H_2O$ ,  $N_2H_4$  and the AKM products.

#### 4.6.10 Venting

Venting shall be sufficient to allow the instrument to withstand the launch pressure profile and thermal vacuum venting.

- (c) Thermal capacity.
  - (d) Heat absorbed by each external node (transient, sun, albedo, and earth IR) versus sun angles and orbit times for at least the  $= 0^\circ$ ,  $28^\circ$ , and  $68^\circ$  sun angle orbits.
  - (e) Surface areas, absorptances, emittances and external radiative couplings for all external nodes.
  - (f) Temperature profiles assumed for adjacent components shall be provided, if used.
- (5) The instrument designer shall validate the reduced thermal model by making comparisons with his general thermal model for at least three transient computer runs. The results of that comparison shall be provided. The mean internal temperatures resulting from both models should agree within  $3^\circ$  C. The heat transferred to or from the spacecraft should agree within approximately 1/2 watt.
  - (6) One of the computer runs shall be included in the data package.

#### 4.7.5.6 Thermal Blankets

The contractor shall be responsible for the design of and shall supply any and all thermal blanketing which may be required. All flight blankets shall be baked out for a minimum of 48 hours in vacuum at  $80^\circ\text{C}$  prior to shipment to the spacecraft contractor's facility.

#### 4.7.6 Description of the Solar (Gamma) Angle

Because the spacecraft Z axis will be nominally coaligned with the orbit normal, the gamma angle can be defined as the angle between the satellite-to-sun line and the spacecraft Z axis. The angle may vary between zero and  $80^\circ$  degrees, depending on the orbit, and will trace a cone about the Z axis during each orbit. The spacecraft will be in eclipse for a portion of each orbit for all gamma angles greater than  $28^\circ$  degrees, the duration of eclipse increasing with gamma angle. This period of eclipse will occur when the sun is in the third and fourth quadrants (below the Y-Z plane) as seen from the spacecraft.

In general a spacecraft in a morning, descending node orbit may encounter gamma angles from  $0^\circ$  to  $40^\circ$  degrees, depending on the orbit, and spacecraft in an afternoon, ascending node orbit may encounter gamma angles from  $40^\circ$  to  $80^\circ$  degrees, depending upon the orbit. While the instrument must be designed to accommodate the entire gamma angle range SBUV/2 will be flown primarily on afternoon spacecraft and will be positioned on the spacecraft to optimize diffuser performance at the higher gamma angles. Specific mission requirements are defined in the SBUV/2 Unique Instrument Interface Specification (IS2295548).

Figure 4.2     Deleted

#### 4.8 CONTAMINATION CONTROL

To minimize particulate contamination, the flight hardware shall continuously be maintained in a clean environment equivalent to class 10,000 as defined in Fed Std 209B. When the instrument is in an area which is not class 10,000, e.g., the spacecraft contractor's integration area, the optics must be protected. Precautions shall be taken such that body oil (fingerprints), facial hair, etc., shall not come in contact with flight hardware. To minimize molecular contamination, items such as Tygon tubing, materials containing plasticizers, etc., shall not be used or stored in the vicinity of flight hardware. A procedure defining the contamination control efforts and flight hardware cleaning shall be prepared and submitted for review and approval at the time of the CDR; 3 copies are required.

##### 4.8.1     Molecular Contamination

A two-way deployable cover (i.e., one that can be opened and closed upon command) shall be provided to protect the critical optical elements of the SBUV/2 from molecular contamination, excessive quantities of which are expected to be deposited on the SBUV/2 during the launch phase of the flight. It is also possible that molecular contamination sufficient to degrade instrument performance will occur in spacecraft thermal vacuum testing, therefore, the cover shall be operable in a 1g field as well as a zero g field. For details see Applicable Document No. 2.1(12).

### 5.3.2 Requirements

(1) The BCU shall be a functional duplicate of the System Test Equipment (STE).

(2) Deleted

(3) Deleted

(4) Deleted

(5) Deleted

(6) The contractor is required to deliver all cabling to be used with the BCU and the Repeatability Test Fixture.

(7) The contractor is responsible for maintaining the BCU, including the automated data system and software, until the end of the contract, with the exception of designated stand-alone commercial test equipment. This latter equipment will be maintained and calibrated by the spacecraft contractor while the equipment is at his facility.

## 5.4 VACUUM CHAMBER AND OTHER AMBIENT TEST EQUIPMENT

### 5.4.1 Vacuum Chamber Test Equipment

The chamber test equipment shall consist of a vacuum chamber test fixture, which shall be compatible with the STE and all UV calibration sources. This Vacuum Test Fixture (VTF) shall be used to accommodate the instrument and sources for all tests requiring use of the vacuum chamber.

#### 5.4.2 Primary Test Fixture (PTF)

The contractor shall construct a PTF which shall be used in conjunction with the STE for all system functional checks, electrical checks, ambient performance test and primary calibration, which can be done in the clean room. This fixture will be as identical as possible to the VTF in order to eliminate fixture related changes in the test data

#### 5.4.3 UV Calibration Targets

One set of targets shall be used at the contractor's facility, where it is practical to do so, to provide the baseline radiance and irradiance calibration of the SBUV/2 and to demonstrate its flight worthiness. Where it is not practical to share a UV source or target between the VTF and PTF, a second copy will be procured.

#### 5.4.4 Target Control Consoles

The contractor shall provide one control console for each independent set of targets. The control units shall be designed to drive and control the UV sources, and provide collection and readout capability for all required target telemetry data. These consoles shall have provision to read the target's telemetry into the STE. The contractor is responsible for maintaining all source control consoles until the end of the contract.

#### 5.4.5 Cables and Connectors

The spacecraft contractor will provide all cabling required for spacecraft thermal vacuum testing.

#### 5.4.6 Contamination Control

Prior to testing of flight hardware, a bake-out shall be conducted with all test equipment, e.g., fixtures, harnessing, etc. A quartz crystal microbalance shall be used and the test concluded when the accretion rate drops to 150 counts per hour or less. Witness mirrors shall be installed in the chamber during the bake-out as well as during thermal vacuum testing of the flight hardware. These mirrors shall be provided by and returned to GSFC for evaluation.

#### 5.4.7 Deleted

## 5.5 DRILL FIXTURES

The contractor shall provide two drill fixtures for the ELM which are referenced to the ELM axis. One shall be retained by the contractor for drilling the mounting holes in the SBUV/2 and the other will be used by the spacecraft contractor for drilling mounting holes in the spacecraft. A drawing(s) of the fixture shall be submitted to the Technical Officer for approval prior to fabrication. The fixture drawings shall include:

- (1) Permanent drill bushings with slip bushing inserts sized to accomodate mounting bolts.
- (2) Marking to indicate which surface of the fixture contacts the spacecraft.
- (3) Mounting hole locations and tolerances.
- (4) Outline of the ELM package.
- (5) Orientation of fixture with respect to spacecraft.
- (6) Size of mounting hardware.

The fixture shall be provided with permanent drill bushings as defined in (1) and shall be marked to indicate which surface of the fixture contacts the spacecraft and its orientation with respect to the spacecraft.

## 5.6 SOFTWARE

The contractor shall generate all required computer programs which will be used in the processing and interpretation of the test and calibration data. These shall include, but not necessarily be limited to the following: An instrument calibration program, a data logging program, a limit check program, and any other software required for special data processing, output formatting and special data tape generation.

#### 5.7 HANDLING AND LIFTING FIXTURES

The contractor shall provide a handling fixture for each SBUV/2 Sensor Module. This fixture must be designed to prevent excessive direct handling of the Sensor Module during assembly, test and shipment operations. The handling fixture shall be shipped with the Sensor Module for use at the spacecraft contractor's facility.

The contractor shall provide a removable lifting fixture with the proto-flight unit for use in lifting and transporting the Sensor Module from its container to the FSM. This fixture will be used to attach the Sensor Module to an overhead crane.

The lifting fixture will be retained by the spacecraft contractor for use on subsequent flight instruments. Handling fixtures will be returned to the contractor, along with the shipping containers, following launch of the instrument.

#### 5.8 OTHER EQUIPMENT

The contractor shall provide all other facilities and test equipment required for fabrication, subsystem testing, functional testing, and final acceptance testing of the SBUV/2.

## 6.2 PROTOFLIGHT LEVEL ENVIRONMENTAL TEST REQUIREMENTS

### 6.2.1 General

The SBUV/2 engineering and protoflight models shall be subjected to the following qualification level environmental tests. Except where noted the unit must meet all specified performance criteria during these tests. The unit is to be operated during these tests in a manner simulating actual operation during the various flight stages. The use of any environmental facility other than those at the contractor's own plant requires prior approval in writing from the Technical Officer.

### 6.2.2 Acceleration Test

An acceleration test shall be conducted where 13.8g longitudinal and 3g lateral loads shall be applied simultaneously first in the +Z and +X then in the +Z and +Y direction (spacecraft coordinates) for one minute. The test may be conducted on the engineering or structural model only if the prime structure is identical to that of the protoflight model.

### 6.2.3 Load Analysis Alternative

In lieu of the acceleration test as specified above, a load analysis may be submitted which shows that the primary load bearing structure can withstand an 18.4g longitudinal and 4g lateral load applied simultaneously in the "+Z and +X" and "+Z and +Y" directions. This analysis must be submitted two (2) months prior to the initiation of the engineering model environmental test program.

### 6.2.4 Vibration Tests

The SBUV/2 engineering and protoflight units shall be subjected to the following qualification level vibration test in each of three orthogonal axes; during these tests the instrument shall be in its launch configuration.

Z-Z: Thrust axis, as applicable to unit installed on spacecraft.

X-X & Y-Y: Perpendicular to Z-Z and defined as the spacecraft X-X and Y-Y axes.

(a) Sinusoidal Vibration - Qual LevelSensor Module & Electronics Module

| Frequency Range (Hz.) | X-Axis  | Y-Axis  | Z-Axis  | Protoflight Sweep Rate (Octave/Min.) |
|-----------------------|---------|---------|---------|--------------------------------------|
|                       | g Level | g Level | g Level |                                      |
| 5 - 70                | 4.5*    | 5.0*    | 4.0*    | 4.0                                  |
| 70 - 2000             | 1.5     | 2.5     | 1.0     |                                      |

\*Displacement Limited to 0.5 inch Double Amplitude

(b) Random Vibration - Qual LevelSensor Module - Z Axis

| Frequency Range (Hz) | Power Spectral Density ( $g^2/Hz$ ) | G-RMS | Protoflight Duration (Min.) |
|----------------------|-------------------------------------|-------|-----------------------------|
| 20-75                | 0.005                               | 5.9   | 1.0                         |
| 75-150               | +10dB/Oct.                          |       |                             |
| 150-500              | 0.05                                |       |                             |
| 500-2000             | -7dB/Oct.                           |       |                             |

Sensor Module - X and Y Axes

| Frequency Range (Hz) | Power Spectral Density ( $g^2/Hz$ ) | G-RMS | Protoflight Duration (Min./Axis) |
|----------------------|-------------------------------------|-------|----------------------------------|
| 20 - 75              | 0.011                               | 7.1   | 1.0                              |
| 75 - 150             | +10dB/Oct.                          |       |                                  |
| 150 - 310            | 0.11                                |       |                                  |
| 310 - 350            | -18dB/Oct.                          |       |                                  |
| 350 - 500            | 0.05                                |       |                                  |
| 500 - 2000           | -7dB/Oct.                           |       |                                  |

Electronics Module - All Axes

| Frequency Range (Hz) | Power Spectral Density ( $g^2/Hz$ ) | G-RMS | Protoflight Duration (Min./Axis) |
|----------------------|-------------------------------------|-------|----------------------------------|
| 20 - 75              | 0.011                               | 8.8   | 1.0                              |
| 75 - 150             | +10dB/Oct.                          |       |                                  |
| 150 - 500            | 0.11                                |       |                                  |
| 500 - 2000           | -7dB/Oct.                           |       |                                  |

6.2.5 Shock Alternative

In lieu of a sine test from 110-2000 Hz the following shock test may be substituted: Engineering Model and Protoflight; Apply the qualification shock spectrum, pulse or complex transient, once along the 3 major axes of the test item. See figure 6.1.

### 6.2.6 Launch Phase Pressure Profile

The maximum pressure rate of change will take place at about 7.7psia, drop at a rate of 1.27 psia/sec for one second, then at rates of 0.6, 0.4 and 0.3 psia/sec, respectively, during each of the next three seconds. The instrument design shall be such that, when subjected to the above environment, no adverse conditions will result which may affect instrument performance.

### 6.2.7 Acoustic Test Requirement

The spacecraft with its payload, as part of its environmental testing sequence, shall be exposed to the acoustic levels shown in Table 6.1. During launch, a similar environment is expected inside the shroud.

The specified instrument random vibration levels are based upon the acoustic levels, which are coupled with and conducted through the spacecraft structure and, finally, mechanically transmitted to the instruments. Since the random levels envelope the transmitted acoustic levels, there is no requirement for acoustic testing of the instruments.

The contractor should review his instrument for large area/low mass components which would be exposed to and could be affected by direct acoustic energy. Such instrument components may require an acoustic test to assure adequate performance.

$$Q = 10$$

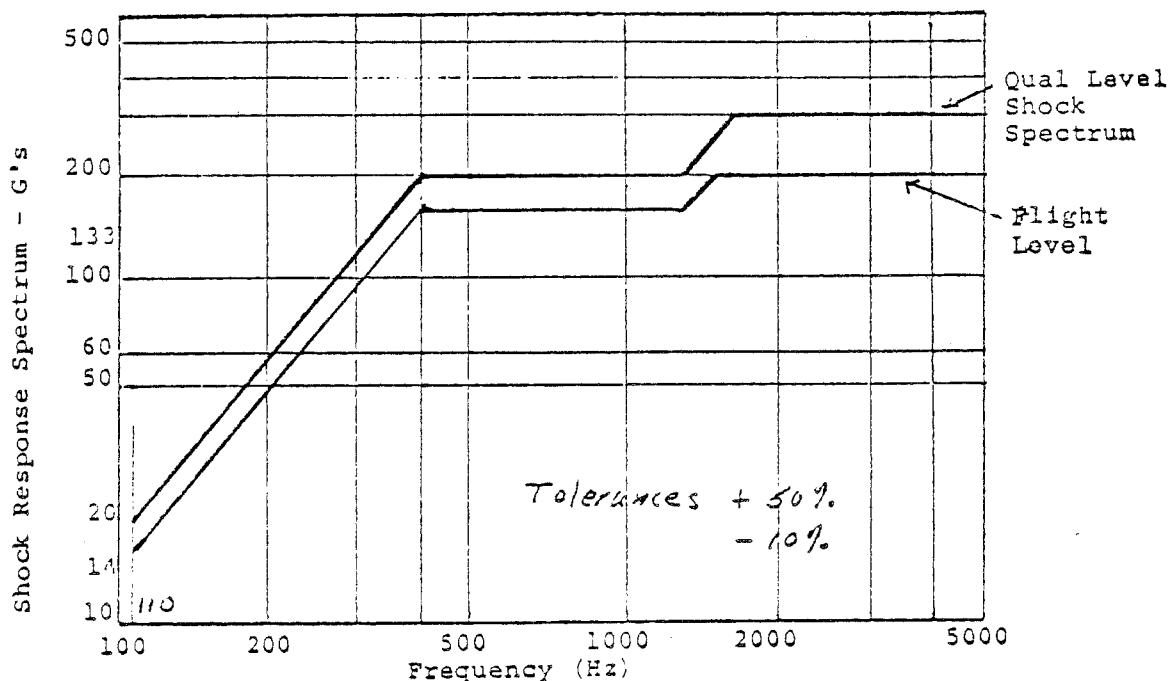


Figure 6.1 Qual and Flight Level Shock Spectrum

Table 6.1

## Acoustic Qualification Criteria - Internal Levels

| 1/3 Octave Band<br>Center Frequency (Hz) | 1/3 Octave Band<br>Sound Pressure Level (dB) |
|--|--|
| 40                                       | 120.5  |
| 50                                       | 123  |
| 63                                       | 125  |
| 80                                       | 126.5  |
| 100                                      | 128.2  |
| 125                                      | 130  |
| 160                                      | 131.5  |
| 200                                      | 133  |
| 250                                      | 133.8  |
| 315                                      | 134.5  |
| 400                                      | 134.75                                       |
| 500                                      | 134  |
| 630                                      | 133  |
| 800                                      | 130.5  |
| 1000                                     | 128  |
| 1250                                     | 125.5  |
| 1600                                     | 122.5  |
| 2000                                     | 119  |
| 2500                                     | 116  |
| 3150                                     | 113  |
| 4000                                     | 109  |
| 5000                                     | 106  |
| 6300                                     | 102  |
| 8000                                     | 98   |
| 10000                                    | 95   |
| OA                                       | 147.3  |

The test duration will 1.0 minute.

#### 6.2.8 Thermal Vacuum Qualification Test Requirements

The SBUV/2 engineering and protoflight instruments shall be subjected to a thermal vacuum test in which the pressure is  $1 \times 10^{-5}$  torr or less and the test temperature profile is as shown in Figure 6.2. The unit will be in the launch phase mode for pump down and in the mission mode for all other phases of this test. The temperature extremes shall be 10°C more severe than the

temperature extremes expected during worst case orbital conditions, as measured at the instrument baseplate. During temperature transitions the rate of change in temperature shall not exceed 10°C per hour or be less than 5°C per hour. The instrument is required to operate over this temperature range and survive but need not operate, radiometrically, within specification below 0°C or above +30°C as measured at the baseplate, unless the contractor's thermal design requires it (see section 4.7.5.1).

Thermocouples or thermistors shall be attached to the unit in sufficient numbers to measure the maximum and minimum structural temperatures as well as those critical temperatures required for calibration purposes and survival. The control point of the test for conformance to the specification shall be based on the thermal instrumentation of the baseplate. This instrumentation shall not invalidate the true nature of the thermal environment being measured.

#### 6.2.8.1 Thermal Balance Test

The contractor shall design and perform a special thermal vacuum thermal balance test on the engineering model to confirm the instrument's thermal design. The instrument shall be mounted as it will be on the spacecraft to the temperature controlled interface which can be varied between 0°C and +30°C. As a minimum requirement, the worst hot case and worst cold case conditions, determined from analysis, should be simulated on the instrument. Lamps, heaters, and cooled shields may be used to simulate the expected orbital thermal environment including transients. This test will be used to validate the general thermal model.

#### 6.2.8.2 Shutdown and Restart Tests

System shutdown and restart in orbit shall be simulated. At the extreme thermal vacuum temperature plateaus the instrument shall be shut down and temperature allowed to stabilize before the instrument is restarted. Once all temperatures are stabilized the unit will be restarted and warmup time measured. Care must be taken to insure that the instrument does not go below the minimum allowed temperature during temperature stabilization at the low temperature plateau.

#### 6.2.8.3 Vacuum Environment

For the protoflight model and all subsequent flight models the vacuum environment shall be oil free, i.e., oil diffusion pumps shall not be used.

#### 6.2.9 Electromagnetic Interference and Electromagnetic Compatibility Tests

The contractor shall perform an EMI/EMC test of the SBUV/2 engineering model in accordance with, and to the levels specified in the SBUV/2 UIIS. The spacecraft contractor shall provide the instrument unique harness for use in these tests.

Any degradation in subsystem performance during EMI/EMC testing shall be immediately reported to the Technical Officer. A telefax report is required and must include the characteristics and magnitude of the observed signal noise, or other effects, and certification of the test environments. In addition, the general test reporting requirements remain in effect.

#### 6.2.10 Particle Radiation Test

The contractor shall determine the particle radiation susceptibility of the SBUV/2 with particular emphasis on the in specification operation of the instrument in the radiation environment of the TIROS orbit for the required life of the spacecraft. A test plan which outlines the contractor's specific approach to the radiation survival testing problem shall be submitted to the Technical Officer for review as early in the program as possible.

The contractor shall demonstrate by test that the SBUV/2 can absorb the expected integrated and instantaneous dose of protons and electrons as reflected in reference document 2.1 (10), and meet the performance requirements in all portions of the orbit.

##### 6.2.10.1 Particle Radiation Test Alternative

In lieu of the Particle Radiation Test, the contractor may submit a protection plan accompanied by an analysis, showing that the instrument will survive the radiation test. This analysis must be submitted by the PDR.

#### 6.2.11 Magnetic Field Tests

##### 6.2.11.1 Magnetic Field Strength

The contractor shall map the static and dynamic magnetic field strength of the instrument at a distance of one meter, while the instrument is mounted in a field free environment. Field strengths less than 10 gamma need not be recorded.

#### 6.2.11.2 Magnetic Field Strength Alternative

If the contractor can demonstrate by analysis and/or subassembly tests that the residual magnetic field will not exceed a strength of 200 gamma ( $2 \times 10^{-3}$  Gauss) at a distance of one meter, and if the instrument can be degaussed by the spacecraft contractor, the mapping requirement of paragraph 6.2.11.1 can be waived by written approval of the Technical Officer.

#### 6.2.11.3 Magnetic Susceptibility

The contractor shall determine by measurement the susceptibility of the instrument to the fields generated by the spacecraft, as defined in the GIIS and UIIS. (See paragraph 4.6.8.1 of this document).

#### 6.2.11.4 Magnetic Susceptibility Test Alternative

The contractor may submit an analysis and/or detector test results in lieu of the total instrument magnetic susceptibility test if the analysis can establish that instrument performance will not be affected by the magnetic fields generated by the spacecraft.

### 6.3 FLIGHT LEVEL ENVIRONMENTAL TEST REQUIREMENTS

The environmental acceptance test requirements for the follow-on flight units differ from the protoflight level requirements as follows:

- (1) Delete paragraphs 6.2.2, 6.2.3, 6.2.7, 6.2.8.1, 6.2.9, 6.2.10, and 6.2.11.
- (2) Change Paragraph 6.2.4 to read:

(a) Sinusoidal Vibration - Flight LevelSensor Module & Electronics Module

| Frequency Range (Hz) | X-Axis g Level | Y-Axis g Level | Z-Axis g Level | Protoflight Sweep Rate (Octave/Min.) |
|----------------------|----------------|----------------|----------------|--------------------------------------|
| 5 - 70               | 3.6*           | 4.0*           | 3.2*           | 4.0                                  |
| 70 - 2000            | 1.0            | 2.0            | 0.8            |                                      |

\*Displacement Limited to 0.5 inch Double Amplitude.

(b) Ramdon Vibration - Flight LevelSensor Module & Electronics Module - All Axes

| Frequency Range (Hz) | Power Spectral Density ( $g^2/Hz$ ) | G-RMS | Protoflight Duration (Min./Axis) |
|----------------------|-------------------------------------|-------|----------------------------------|
| 20 - 75              | 0.005                               | 5.9   | 1.0                              |
| 75 - 150             | +10/dB/Oct.                         |       |                                  |
| 150 - 500            | 0.05                                |       |                                  |
| 500 - 2000           | -7dB/Oct.                           |       |                                  |

- (3) In paragraph 6..5, use the lower curve in Figure 6.1.
- (4) In paragraph 6.2.8, change the temperature extremes to +0 degrees C and +30 degrees C.

#### 6.4 SYSTEM PERFORMANCE TEST REQUIREMENTS

##### 6.4.1 Specification Compliance Test

The contractor shall perform all tests necessary to unequivocally demonstrate that all quantitative instrument performance requirements of this specification have been met. This includes all requirements placed on subsystems and components by this specification, directly or indirectly.

##### 6.4.2 Bench Tests

The BCU shall be used by the contractor to operate the instrument during the system performance tests off site and whenever a limited quick-look check or trouble-shooting is required. It will be used at the spacecraft contractor's plant for incoming acceptance tests and for any other system evaluation tests which might be required.

##### 6.4.3 General Electrical Performance Test

The contractor shall devise a short but comprehensive electrical performance test which shall form the basis of the bench check test. This test shall be used in conjunction with other tests as a check of instrument performance before and after certain environmental tests. This test shall include use of breakout boxes to measure critical electrical parameters which would not normally be monitored by the spacecraft. It is intended that the availability of the automated data processing equipment shall not be a prerequisite.

##### 6.4.4 General Optical Performance Test

The contractor shall devise a short but comprehensive optical performance test to be used in conjunction with the general electrical performance test, to demonstrate that the instrument is in compliance with the optical requirements. This test will be performed before and after any system environmental test which might change instrument performance, and after the instrument has been shipped or subjected to any non-standard environment.

##### 6.4.5 Ground Support Equipment Tests

The contractor shall design and perform tests as required to demonstrate that all GSE is functioning properly and within specification.

##### 6.4.6 Deleted

## 6.5 SYSTEM CALIBRATION TEST REQUIREMENTS

### 6.5.1 General

The determination of instrument response versus scene radiance of each spectral band must be a comprehensive test of the system design and performance. This test must be capable of producing the information needed for processing the data gathered in orbit. The calibration shall be planned to 1) demonstrate subsystem performance, and 2) provide the data from which the initial regression coefficients, used to compute the slope and intercept which defines the corrected mean response of the instrument, can be determined. The regression coefficients are primarily a function of instrument component temperature.

It is also required that all temperature and voltage monitors be calibrated. Equations and/or coefficient data tables for converting instrument output to a voltage or temperature, including all raw data, are to be provided as part of the Alignment and Calibration Data Book.

### 6.5.2 Calibration of System Response

The contractor shall calibrate and test the instrument to determine its response to a known stimulus and to determine all significant corrections to this response for the full expected range of instrument interface temperature. The calibration environment for the instrument shall simulate the expected orbital thermal environment, using heaters as sources, and the instrument shall be tested with its full complement of shields and thermal insulation.

#### 6.5.2.1 Sources

For instrument radiometric calibration the contractor shall use a NBS standard source(s) of spectral irradiance appropriate to the wavelength range in question. All calibrations are to be done in air when possible, but response reproducibility checks will be made in vacuum. For scene radiance measurements an external near lambertian diffuser shall be used while solar irradiance measurements are to be made using the instrument's diffuser. During calibration all steps required to correct the instrument's response for changes in the external diffuser, if any, are to be taken. This may include making a fresh external diffuser for each measurement.

#### 6.5.2.2 Radiometric Calibration Plateaus

Radiometric response calibration measurements utilizing the argon arc, quartz iodide (QI) lamp or any other standard source shall be made at the following instrument baseplate temperatures for both the Discrete and Sweep Modes of operation: 0°C, +10°C, +20°C, and +30°C, providing the instrument baseplate follows the external ESM temperature. If the baseplate does not follow the ESM temperature, the instrument must be calibrated at 10°C increments over its actual temperature range. If the instrument temperature is

controlled to some value 'To' calibration must be performed at To and To + 10°C only. The stability of the baseline calibration shall be established in all channels at each temperature plateau prior to leaving that plateau.

#### 6.5.2.3 Radiance Calibration

In the Discrete Mode the monochromator shall be stopped at each spectral band and a minimum of 50 samples taken for the baseline calibration. For measurements made with the argon or deuterium arcs, the arc shall be "restruck" and the measurement sequence repeated several times to establish a statistical sample of source irradiance. The number of source intensities used will be determined by the results of the linearity calibration. The baseline source intensity used for instrument calibration shall be of sufficient strength to establish a minimum instrument signal to noise ratio of 200 for each operating mode over the spectral range 200nm to 400nm. Similar measurements shall be made for the cloud cover radiometer. Subsequent operational mode calibration checks shall be made by gathering a minimum of 30 samples of data for each spectral band with the instrument operating normally in the Discrete Mode. To establish the baseline calibration in the Sweep Mode, a minimum of 30 consecutive "scans" shall be taken and the data processed as outlined below.

#### 6.5.2.4 Linearity Calibration

The contractor shall provide a calibration of system linearity. A minimum 20 point calibration, equally spaced over the instrument dynamic range, is required, but need be done at only one wavelength within the spectral range of the instrument.

#### 6.5.2.5 Diffuser Calibration

The contractor shall provide a goniometric calibration of the on board diffuser, over the angular range to be encountered in orbit, and shall perform a goniometric calibration of the instrument with the diffuser in place. This includes irradiation angles as well as SBUV/2 viewing angles.

#### 6.5.2.6 Instrument Calibration Software

The contractor shall provide calibration software which will generate a specially formatted data dump in near real time and/or off line from the history tape. This specially formatted dump shall contain a header with the instrument number, data, test condition and any other pertinent information necessary for utilization of the data. The dump shall also include the following processed data:

##### Discrete Mode and Cloud Cover Radiometer

- (1) The mean and standard deviation of the raw data (in counts) shall be determined for each source intensity at each instrument

## 6.6 ENGINEERING MODEL TEST REQUIREMENTS

The engineering model SBUV/2 shall be subjected to the same environmental, performance, and calibration tests as the protoflight unit with the following changes:

- (1) Thermal balance test will be added, (6.2.8.1)
- (2) EMI/EMC tests will be added (6.2.9)
- (3) Paragraphs 6.2.2, 6.2.7, and 6.2.10 will be deleted.

## 6.7 SPECIAL DATA REQUIREMENTS

### 6.7.1 History Tapes

The contractor shall generate a digital history tape, containing all SBUV/2 output data plus all ancillary data, whenever the instrument is operated from the STE. All blank tape will be provided as GFE.

### 6.7.2 Special Data Tapes

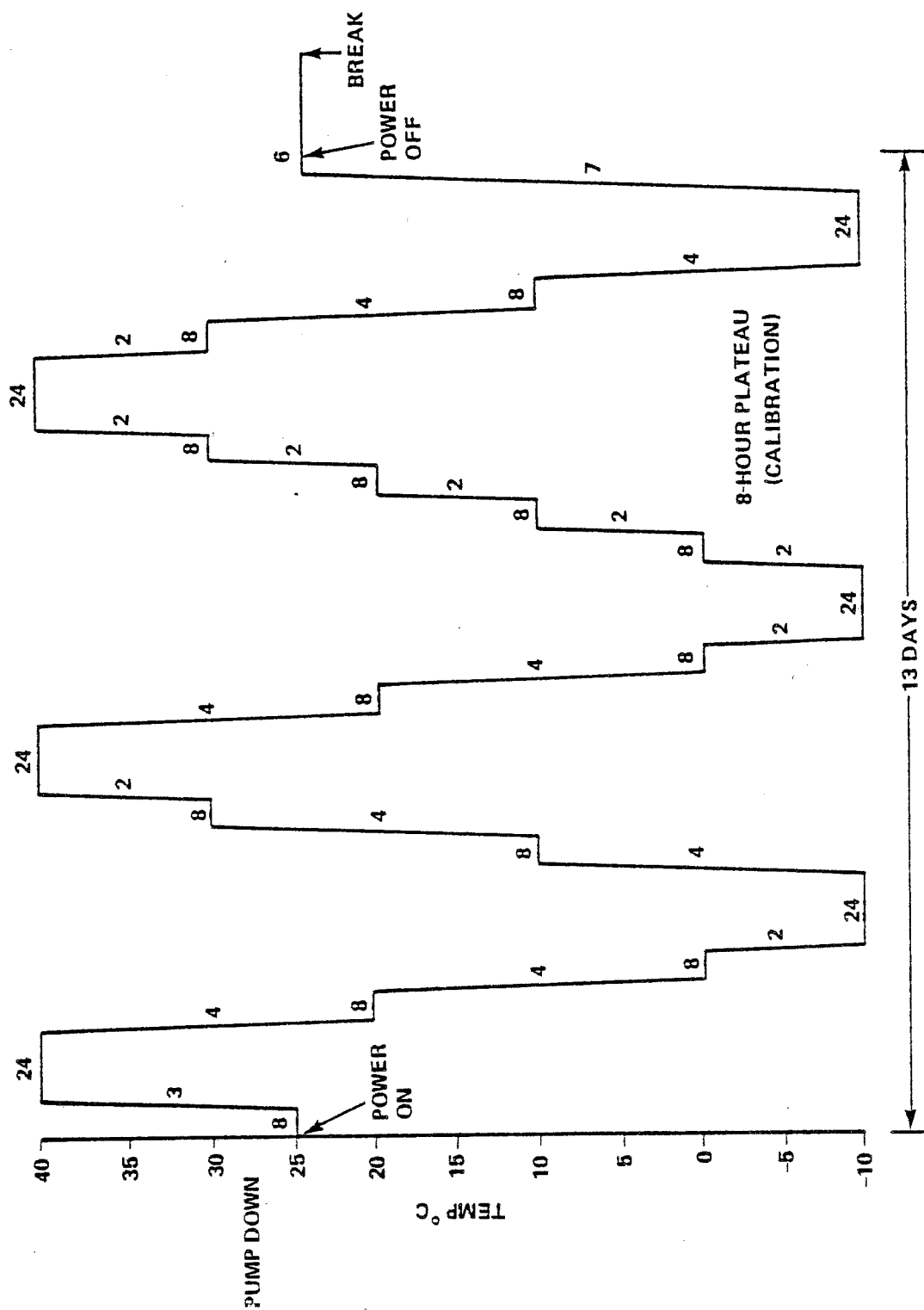
The contractor shall generate a specially formatted data tape, in real time or from the history tape, during instrument calibration. The data tape(s) shall cover the entire calibration cycle and shall be forwarded to GSFC for transmittal to NOAA on a timely basis.

Special data tapes, in the same format as above, may be required from other selected periods of the acceptance test cycle, including portions of the thermal vacuum testing.

Blank digital tape will be provided as GFE, as required.

## 6.8 TIP COMPATIBILITY TEST

Before delivery of the engineering model (prior to the CDR) the TIP Simulator (TIPSI) shall be brought to the contractor's facility for a checkout of the instrument/spacecraft interface. TIPSI will be operated by GSFC personnel.



## GLOSSARY OF ABBREVIATIONS AND ACRONYMS &amp; ANCILLARY DATA

|      |  |
|------|--|
| AKM  | Attitude Kick Motor                        |
| BPI  | Bits per Inch                              |
| BPS  | Bits per Second                            |
| BCU  | Bench Check Unit                           |
| CCB  | Configuration Control Board                |
| CCR  | Cloud Cover Radiometer                     |
| CDR  | Critical Design Review                     |
| CMOS | Complementary/Metal Oxide Semiconductor    |
| DIR  | Design Information Report                  |
| ECN  | Engineering Change Notice                  |
| ELM  | Electronics and Logic Module               |
| EM   | Engineering Model                          |
| ESM  | Equipment Support Module                   |
| FOV  | Field of View                              |
| GFE  | Government Furnished Equipment             |
| GIIS | General Instrument Interface Specification |
| GSE  | Ground Support Equipment                   |
| IFOV | Instantaneous Field of View                |
| KBPS | Kilo-Bits per Second                       |
| MFP  | Major Frame Pulse                          |
| MR   | Malfunction Report                         |
| PDR  | Preliminary Design Review                  |
| PF   | Protoflight                                |

## GLOSSARY OF ABBREVIATIONS AND ACRONYMS (Continued)

|        |   |
|--------|---|
| PFM    | Protoflight Model                         |
| PRP    | Phase Reference Pickup                    |
| PLB    | Pulse Load Buss                           |
| PSR    | Preshipment Review                        |
| QI     | Quartz-Iodide                             |
| R & QA | Reliability & Quality Assurance           |
| SM     | Sensor Module                             |
| STE    | System Test Equipment                     |
| TCE    | Temperature Control Electronics           |
| TIP    | TIROS Information Processor               |
| TIPSI  | TIP Simulator                             |
| UIIS   | Unique Instrument Interface Specification |
| WTR    | Western Test Range                        |

Figure 10.1--Actual Work Breakdown Structure  
(Foldout)



11.0 AMENDMENTS TO THE SPECIFICATION

No. 1. The Thermal Balance Test, as defined in paragraph 6.2.8.1, shall be combined with the Thermal Vacuum Qualification Test, as defined in paragraph 6.2.8, for the UMJ/Flight model. All compatible elements of the former test will be incorporated into the Thermal Vacuum Qualification Test and any additional thermal analysis required by the change in test configuration will be performed. The new thermal vacuum test profile for the EMU/flight model is given in figure 11.1.

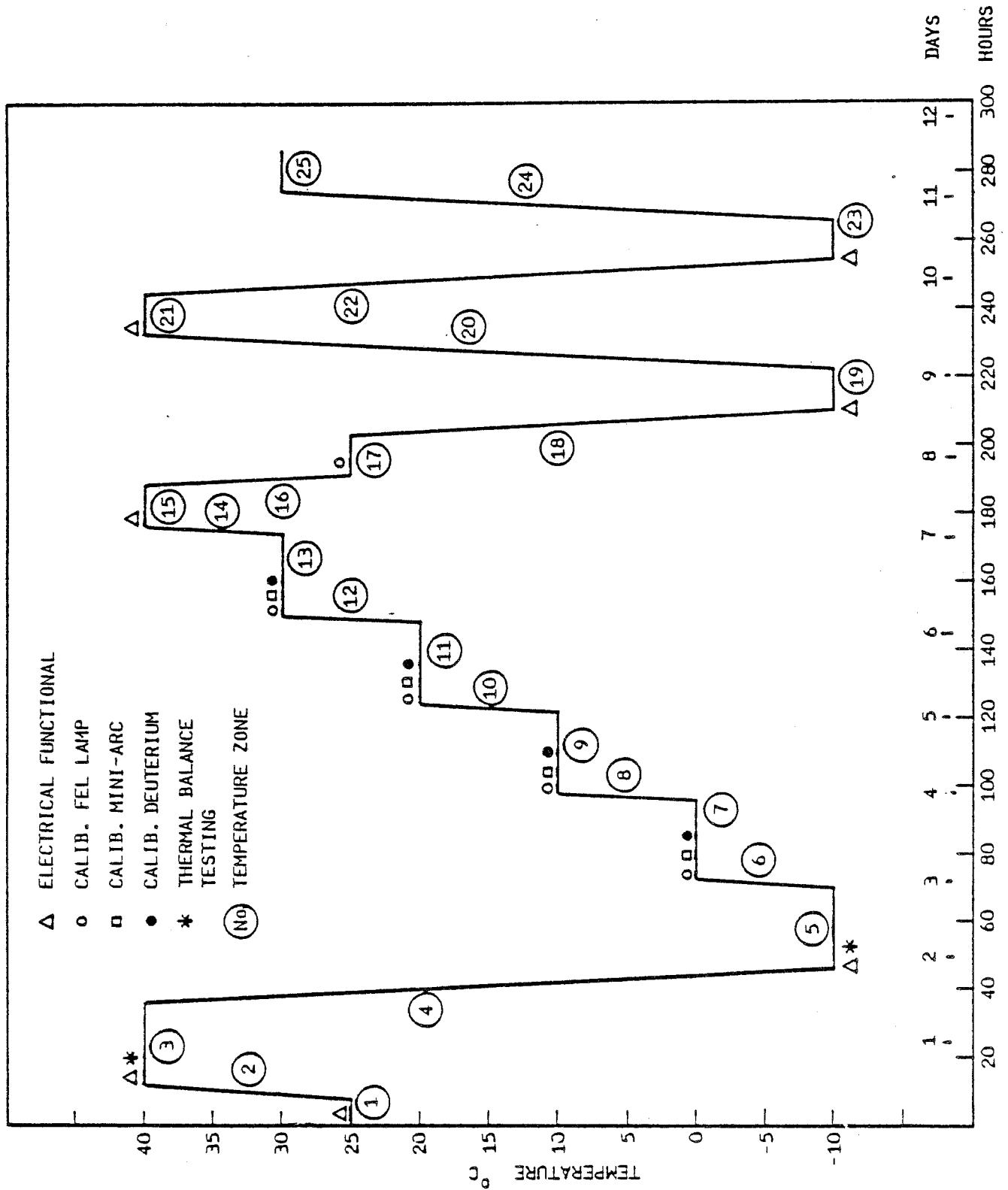


Figure 11.1 Thermal Vacuum Test Profile For The EMU/Flight Model



